Volume II March, 1925 *Number 3*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Machine Tools

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

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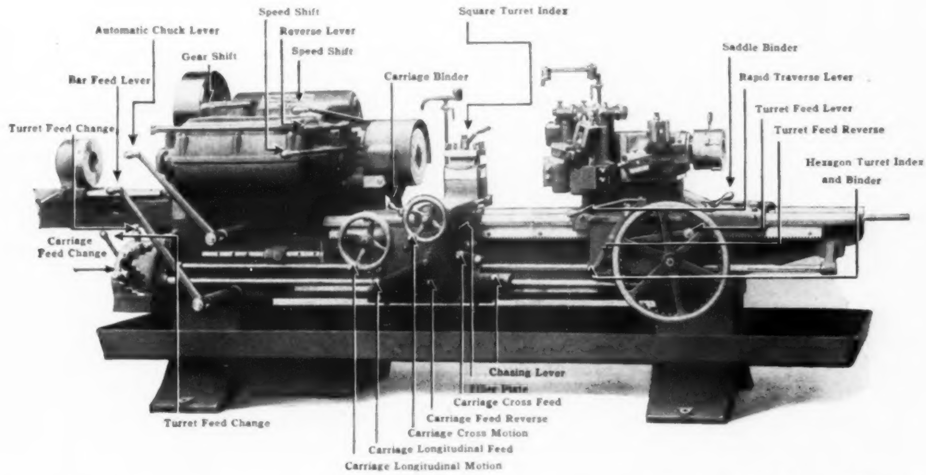
Published Monthly by

The Texas Company, 17 Battery Place, New York City

Vol. XI | March, 1925 | No. 3

Change of Address: In reporting change of address kindly give both old and new addresses.



Courtesy of The Warner & Swasey Co.

Fig. 1.—A universal hollow-hexagon turret lathe. Gearing and clutches on this machine run in a bath of oil. Other moving parts are splash lubricated.

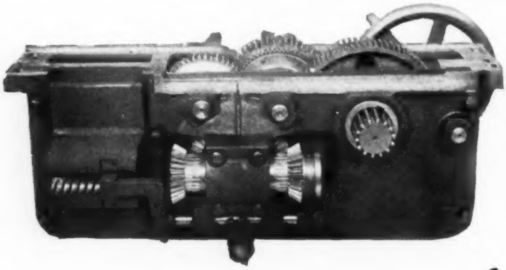
Lubrication of Machine Tools

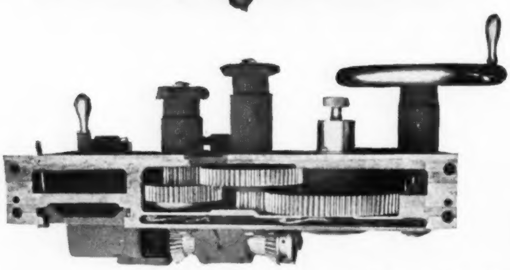
IN MACHINE shop practice today, the life of a cutting tool will depend upon the material from which it is made, the condition of the machine in which it is used, the character of the work which it performs and the extent to which frictional resistance is reduced by suitable lubrication of the cutting and wearing parts.

Intensive methods of production as developed during the war, brought out the fact that machine shop equipment certainly required quite as careful attention from a lubricating point of view as any other equipment in the plant. Especially was this true in the case of high speed apparatus such as the modern grinder, and drilling machine where speeds of several thousand R.P.M. might be necessary. The combined lubrication and cooling of cutting tools such as drills, etc. had long been known to be important, in fact, where high speed tool steels are involved, it has been *estimated that cutting speeds could be increased perhaps 30 to 35 percent by careful attention to the matter of tool lubrication. Yet the essential wearing parts of the machines were frequently so far overlooked and under-lubricated as to materially reduce the potential benefits that effective tool lubrication might involve.

*Battle—Industrial Oil Engineering. Page 635.

Today, however, the modern machine tool engineer views his equipment in a different light. Very forcibly does he appreciate that where accurate work is required in conjunction with maximum production, it is most essential





Courtesy of The Lodge & Shipley Machine Tool Co.

Fig. 2.—Details of a modern lathe apron, side and top views. Positive lubrication of all bearings is attained by capillary attraction through suitable wicks. The oil reservoir is located in the top of the back plate.

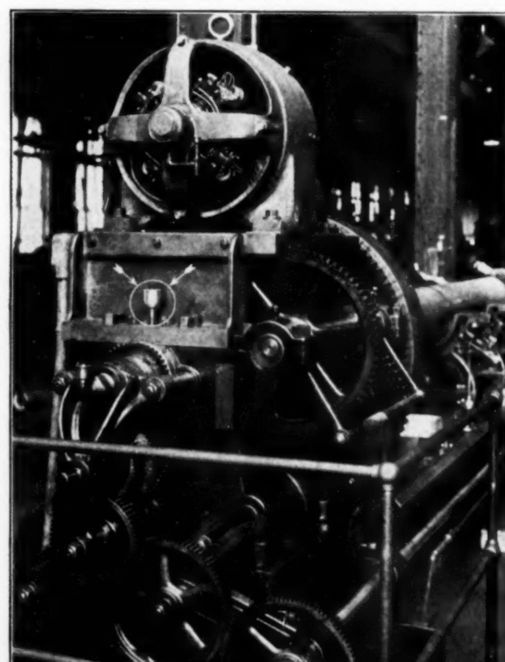
to carefully lubricate every wearing part not only of the machines themselves, but also of all the mechanical equipment connected with their operation.

While this article is to deal more especially with the parts of the average machine tool requiring lubrication and while those parts may be divided into two general classes, i. e., bearings and gears, each of which must frequently be served by lubricants of distinctive characteristics, it is essential to study briefly the machines themselves before we can appreciate the importance of co-related operation which effective lubrication of their wearing parts will afford. In brief, the condition of the machine in which the tool is used is decidedly dependent upon the efficiency of lubrication of its working parts. The progressive machine tool operator appreciates this and the need, therefore, of knowing his machine details perfectly.

LATHES

For the production of parts of duplicate design and the turning and facing, etc., of work of large diameter, the lathe, of turret, engine or vertical type is used. The operations of turning and facing involve essentially a cutting or paring down of the stock or material to be shaped. This is of course performed by a cutting tool of suitable design. As usually carried out, it consists of rotating the work, which is held rigidly by the spindle, in contact with the cutting tool or tools.

The horizontal turret or engine lathe is commonly used for the forming of material up to about 18 inches in diameter. For heavier duty or larger work, a vertical lathe capable of cutting at greater depths is usually preferred. The horizontal lathe is one of the most common machines in the modern industrial plant. Relatively few of us would fail to recognize one at first sight. To function efficiently and enable the maximum of production with a minimum of unit cost, a lathe must be capable of performing a number of various duties at the same time. In other words, it must be able to turn, face, bore or groove as the case may be, or the work may require. Furthermore, it must have a sufficient range of speeds available so that it may be operated at whatever rate is desirable for the shape or nature of the casting



Courtesy of Malcolm H. Smith Co., Inc.

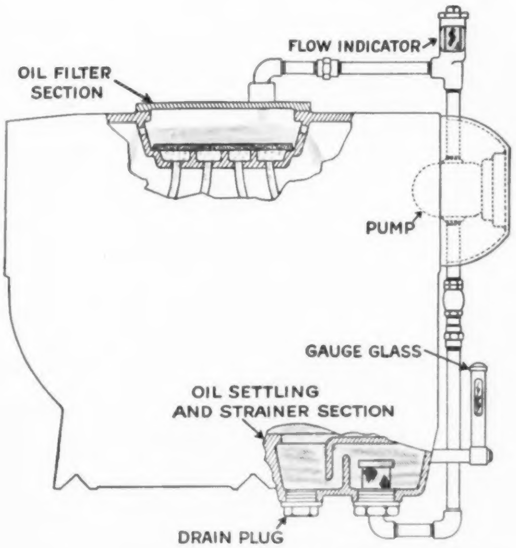
Fig. 3.—End view of a lathe designed for heavy duty. Note the exposed condition of the gears, and that the main bearings are equipped with grease cups.

or forging being worked and the depth of cut that is to be made.

Wearing Parts and Their Lubrication.

The essential wearing parts of the average lathe may be said to involve bearings, slides,

cams and gears. Bearings serve to carry the spindles and other rotating journals; slides or guides support the carriage and turret saddles; cams are used on some machines for regulating the feed, etc.; and gears bring about the



Courtesy of The American Tool Works Co.

Fig. 4.—Details of a modern automatic oiling system on a lathe head. Here the oil is pumped by a Brown and Sharpe oil pump from a reservoir at the bottom, to a distributing chamber in the top cover as shown. Note that all oil is filtered through a felt pad prior to distribution to the bearings.

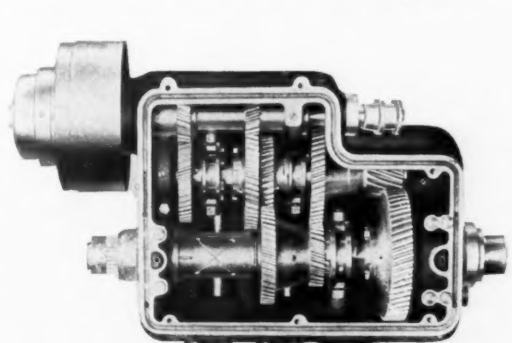
attainment of the necessary speed variations. Gears of course operate the rotating parts, and certain reciprocating details by means of racks.

Bearings may involve a number of types. For example, there will be the thrust bearings which take up the end thrust exerted by the spindle; these may be of the plain shoe type or they may involve ball bearings. Other rotating members may be carried in plain babbit or phosphor-bronze bearings, or in ball or roller bearings. In the case of the spindle, these should normally be capable of adjustment to allow for wear, etc. The higher the speeds, the more attention must be given to the bearings and of course, to their lubrication.

Slides, guides, or ways, as they are sometimes called, include the lathe bed on which the carriage moves, and the guides on which the turret saddle and cross-slide carriage travels. Motion over a lathe sliding surface is relatively slow, but the pressures involved are high. Therefore wear may easily become excessive, with the probability of increased power consumption, if such surfaces are not properly constructed and lubricated. Wherever abnormal friction occurs, the tendency will be for the lathe bed to wear hollow.

The carriage is usually retained in position on the lathe bed by means of V-shaped projections which travel in corresponding grooves in the bed. V-lubrication is important due to the fact that abnormal wear therein will contribute to operating difficulties and the possibility of mis-alignment occurring. For this reason, sliding surface lubrication is receiving considerable attention in the progressive machine shop today. One method of lubrication is to attach felt wipers in the sliding element or on the end of the carriage. These are soaked with oil at periodic intervals. These wipers furthermore aid in keeping the bed V's clear of dirt. Other designs provide for automatic stream lubrication. Still others make use of revolving wheels located in the bedplate, which are so installed as to come in contact with the moving element as it slides over them. These wheels are usually located in a depression which can be partially filled with oil. Thus as they revolve, they carry a film of oil to the moving slide.

Although cams are not extensively installed on many types of lathes, it being found feasible to eliminate them in the design of the moving parts, certain automatic machines will require them for the operation of the reciprocating turret slides, and the work-holding and feeding chucks. To attempt to describe their operation would require an extensive detailed explanation. Therefore we will deal only with their lubrication. Cams may involve much the same principles as do guides, or they may be based on a combination of rolling and sliding motion. Irrespective of their design, it is



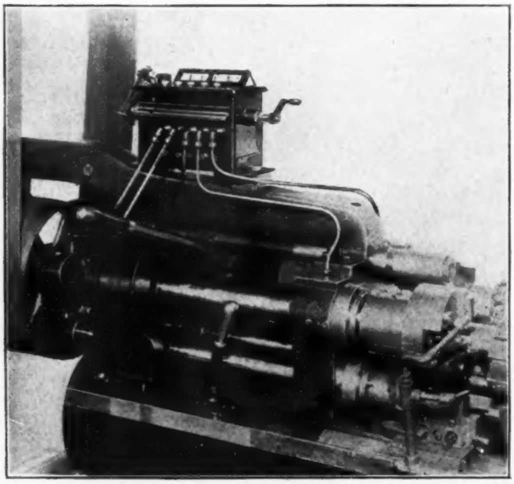
Courtesy of The Monarch Machine Tool Co.

Fig. 5.—View of an eight speed, geared, lathe headstock with the cover removed. All gears run in a bath of oil, splash lubrication being thereby attained.

absolutely essential to prevent abnormal wear, otherwise lost motion and inequalities of operation will occur which will develop imperfection and inaccuracies in cutting. Therefore, cam lubrication wherever involved, is a matter of

moment and quite as important as the lubrication of guides and bearings.

The gears which make possible the attainment of the necessary speeds are probably the most important power members. In most

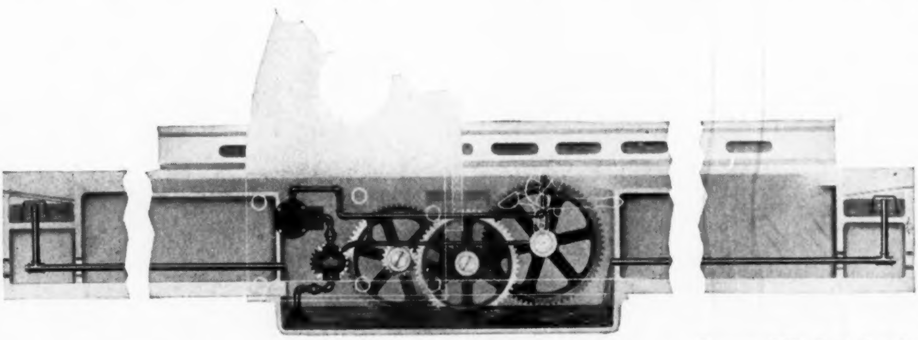


Courtesy of Madison-Kipp Corporation

Fig. 6.—Installation of a mechanical force feed lubricator on a chucking machine. The rate of oil delivery varies in proportion to the speed of the machine.

cases the speed of a lathe will be considerably lower than the speed of the motor; hence, the necessity for the several speed reductions usually found in the average machine. For example, power is transmitted to the spindle through a train of speed change gears enclosed in the head; quick change gear feeds may be used for operation of power feeds; back gears are installed on certain types of engine lathes; and bevel pinions and gears are found in certain speed change gears at least are usually equipped for bath or splash feed lubrication. Not only do these methods insure against the possibility of wear but also they render operation relatively noiseless and preclude the occurrence of back-lash. An added advantage is derived on account of the fact that usually the one lubricant can be made to serve both the gears and their shaft bearings. In most lathes the gears are comparatively small and so carefully designed, cut and aligned that unless excessive wear takes place, lubrication can be effected by means of a relatively fluid lubricant, which will have sufficient viscosity to prevent metallic contact between the gear teeth and still be light enough to penetrate effectively to all the bearings. For this purpose the machine oil generally adaptable to bearing and slide lubrication should be suitable. Usually a viscosity of from 200 to 400 seconds Saybolt at 100 Deg. Fahr. will suffice.

Certain classes of heavier bath lubricated gears on vertical or larger types of horizontal turret lathes may require a heavier bodied oil. Especially would this be true where the gears are enclosed, but have their bearings so located without the gear case as to permit of independent lubrication. In such installations, a viscosity of from 120 to 200 seconds Saybolt at 210 Deg. F. would be advisable, depending on the closeness of mesh and whether back-lash was prone to occur. It must be remembered however, that while a heavier lubricant will eliminate a certain amount of the noise of operation and the pounding and hammering due to back-lash, especially when speeds are changed, the use of too viscous a product might readily involve serious power losses on account



Courtesy of The G. A. Gray Co.

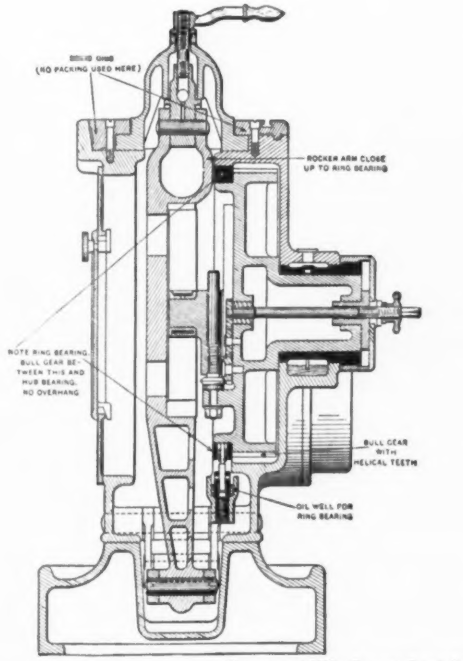
Fig. 7.—Phantom view of a modern planer oiling system, centralized oiling of V-s, gearing and bearings is a feature in this machine.

lathe aprons for the purpose of reversing the direction of feed.

The essence of proper gear operation is their lubrication. This has been fully realized by the progressive machine builders and as a result of the added friction developed by the gears moving through the more or less inert bath of lubricant.

But all lathe gears are not so enclosed as to permit of bath lubrication. Some must there-

fore be lubricated by direct application of the lubricant to the teeth. On such service, the lubricant must not only be sufficiently viscous as to preclude the occurrence of metallic contact between the teeth, but also it must be so



Courtesy of Niles-Bement-Pond Co.

Fig. 8.—Details of a shaper bull gear, showing lubricating features, etc.

adhesive as to stick tenaciously to these latter and resist the action of centrifugal force. Straight mineral gear lubricants are generally preferred for all such exposed gearing. In viscosity they might often have to range as high as 1000 seconds Saybolt at 210 Deg. Fahr. according to the speeds and temperature of operation, and the tooth pressures involved.

PLANERS, SHAPERS AND SLOTTERS

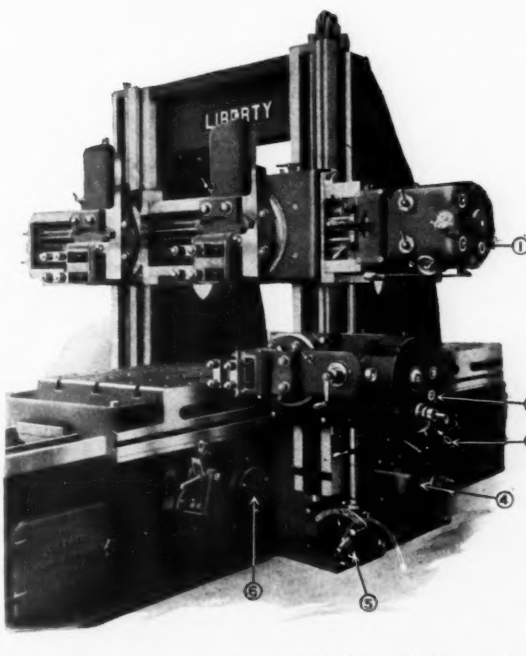
Whereas, in the lathe, the work or material to be cut is usually revolved with respect to the cutting tool, in the planer, shaper or slotter, it is fastened to a table and subjected to reciprocating motion with respect to the tool.

In general, a planer cuts over a flat surface, on the other hand, curved cuts or surfaces can be easily made by the use of tools and attachments especially devised for this purpose. In the average planer, cutting is only performed on the out stroke; the draw-cut or return-stroke cut however, is employed on certain larger machines, as, for example, on plate planers, which are used for the squaring and finishing of flat work such as boiler, tank and ship plates.

So the modern planer essentially involves a series of gears, sliding elements and shaft bearings. The gears are generally regarded as being the most important parts of the planer, for their primary function is to drive the table. Perhaps this is the reason why certain authorities classify planers according to their style of drive, i. e., according to whether they are spur, helical or worm geared.

Either the spur or helical gear drive is usually preferred by the machine tool designer today. Both involve essentially the same principles of operation, the only real difference being in regard to the design of the gear teeth.

In construction, a geared drive consists of a rack which extends over the length of the entire under side of the table. With this rack the "bull" gear or main gear of the driving train meshes. The intermediate set of gears which compose this train serve to bring about the necessary speed reductions from the driving element. The arrangement of these gears is interesting due to the fact that quite a difference exists between the cutting and return speeds. As a rule, the latter will be from two



Courtesy of The Liberty Machine Tool Co.

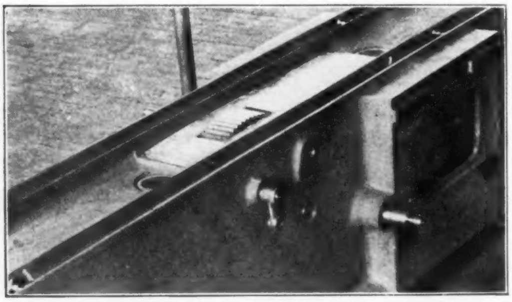
Fig. 9.—View of a planer showing certain of the essential lubricating features, viz.: (6) The cap for enclosing the pressure lubricated bearing; (1) (2) (3) (5) The sight feed oil indicators; (4) The force feed lubricating oil pump.

to four times the former depending upon the size of the machine.

In the worm drive planer a worm takes the place of the "bull" gear, the table rack however remaining the same.

Lubrication

In reality this matter of gear lubrication is practically the salient feature of efficient planer operation. We have already spoken about the occurrence of rolling and sliding friction between the respective teeth as they pass into and out of mesh. Theoretically, this would occur whether the gears were run dry or not. Actually, however, the continued occurrence of solid friction would tend to supplant rolling friction with sliding friction. Wear would thereby tend to increase proportionally. But the substitution of fluid friction for solid friction, which is brought about by the use of a suitable lubricant which will permit of the formation and maintenance of the proper film over the gear teeth, will enable rolling contact to occur as originally designed for, unless of course, the gears work out of line or other faulty operation occurs.



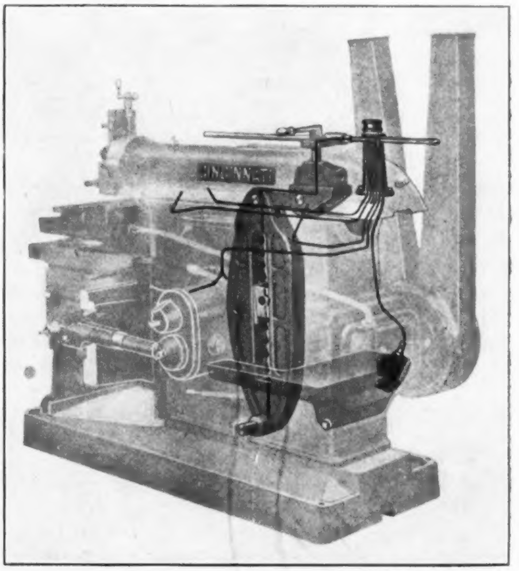
Courtesy of Pratt and Whitney Co.

Fig. 10.—View showing top construction of a planer bed, note cover over gear opening, and the oil strainers.

Therefore it is usually customary to operate all such gears in a bath of lubricant. The character and viscosity of this latter, however, would naturally have to depend upon the design of the gears and case and the type of lubricating system employed. Bath lubrication alone or the mere rotating of the gears suitably immersed in the lubricant will usually permit of the use of a grade of gear lubricant akin to a steam cylinder oil in viscosity. In certain cases this will be a decided advantage, for with a properly enclosed gear case, we could rely on perfect lubrication occurring for a considerable length of time without the necessity for attention or renewal; just as would be possible with the transmission gearing of our automobile. But this would require the stocking of a special grade of gear lubricant.

To get around this, certain builders have designed their machines so as to permit of the use of force feed lubrication. Thus gearing, bearings slides and guides may all be served by the one lubricant under suitable pressure to insure its penetration to all wearing parts. In such systems a straight mineral engine or machine oil of from 200 to 400 seconds Saybolt at 100 Deg. Fahr. would be generally applicable.

The essential sliding mechanisms involved in the average planer include the table V's or guiding grooves such as are described for the lathe, which serve to keep the table in proper alignment with respect to the cutting tool; and such other guides as are necessary to hold the various reciprocating parts in position. V-lubrication is naturally of chief importance, for upon the accuracy and extent to which these guides maintain alignment will depend the accuracy and degree of perfection of the work performed. Planer V's are subject to considerably higher pressures and more wear than are these same parts on a lathe. For this reason they are generally lubricated by force feed or by means of automatic oil rollers of some form. Where force feed lubrication is employed it is usually customary to serve not only the V's but also the guides, and bearings and gears of the rail and other mechanisms. In such a system either a force feed lubricator or an oiling system including a suitable independent pump and reservoir may be used. The force feed lubricator is the more readily attached to an existing piece of equipment.

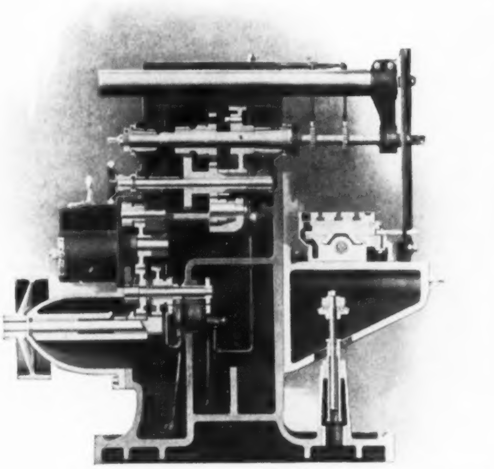


Courtesy of The Cincinnati Shaper Co.

Fig. 11.—Phantom view of the lubricating system of an automatically oiled shaper. This includes a plunger type pump, a sight feed distributing station as shown, etc. Wicks serve to feed the oil from this point to the individual parts of the machine via suitable piping. Clean positive lubrication is, therefore, assured.

For the purpose of general machine lubrication of this nature an oil of 200 to 400 seconds viscosity as recommended for the lathe would be suitable. Gear lubrication wherever it must

be carried out independently of the V's and bearings, will be contingent upon the type of gears and their mode of operation, just as explained for the lathe. Therefore, lubricants as specified or used for these latter will be equally



Courtesy of Kearney & Trecker Corp.

Fig. 12.—A milling machine designed for automatic flood lubrication. The lubricant is stored in the reservoir to the left, being pumped to the top of the machine for distribution to the wearing parts. The two adjacent reservoirs are for storage and settling of cutting lubricants or coolants.

satisfactory if applied to the planer gears. The tendency more and more is to enclose all such gearing in an oil-tight housing; not only does this reduce the hazards of operation but it enables more effective gear lubrication.

Shapers and Slotters

Shapers and slotters as their names suggest, involve metal cutting processes akin to the planer. In other words they are reciprocating tools, the cutting elements of which move through the same horizontal or vertical plane with respect to the stock. In both cases the work is fastened to the table. The cutting tool is held in a ram which receives its motion by virtue of a rack and pinion or some form of crank and link mechanism.

In the shaper the ram and cutting tool operates horizontally or in some cases on a slight angle as in the planer. In the slotter on the other hand, ram and cutting tool operate vertically. Both machines, however, serve to do the same kind of work such as facing, notching, surfacing, etc. over flat surfaces of a great variety of tools and machine parts.

Lubrication

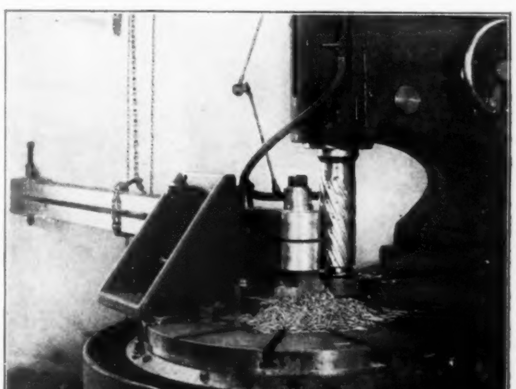
As might be expected, therefore, lubrication of the shaper or slotter differs but little from that of the planer; essentially the same variety of operating mechanisms are involved, hence the same respective grades of lubricants can be used with equal satisfaction.

Automatic lubrication, while of course not universal, is nevertheless generally regarded as an advantage by many leading machine builders. In fact, one manufacturer creates an analogy between his shaper and the automobile in order to drive home the importance of lubrication.

In both the shaper and slotter pressure lubrication involving some form of plunger or geared pump is applicable, just as it is to the planer and certain other types of machines. On deep cutting of hard steel especially, will the pressures exerted on some of the gears and bearings be quite material. Where clearances are relatively high wear might not become abnormal for the lubricating film would be thicker. But high clearances are not conducive to accurate cutting, therefore, they should be always kept within the limits of practical operation.

MILLING MACHINES

In contrast to the lathe, planer, shaper and slotter, which involve but a single pointed tool, the milling machine uses a gang, or multiple cutter, i. e., a tool carrying a number of teeth for the purpose of making a like number of cuts, simultaneously finishing the work at one pass. In the milling machine the cutting tool revolves; the work, held rigidly to a movable table, being automatically adjusted according to the depth of the cut and the rate

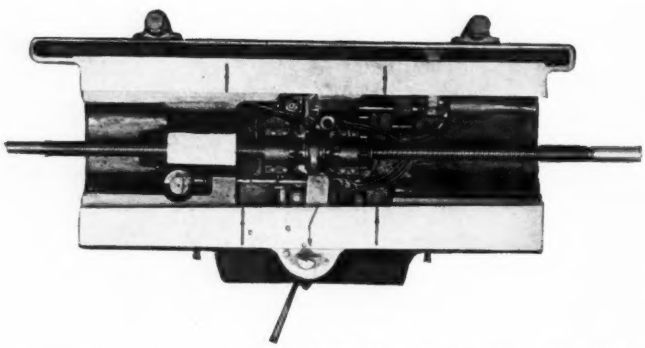


Courtesy of The Ingersoll Milling Machine Co.

Fig. 13.—This illustration will give a clear conception of the nature of a milling cut and the necessity for proper lubrication due to the pressures involved.

of cutting. Perhaps as clear a conception as any of the operation of a milling machine would be to imagine it as a huge rotary file in action. In fact, the earlier machines were in reality but little else.

The milling machine has a wide field in the modern machine shop due to the fact that it can not only be used for cutting of parallel slots or grooves on flat surfaces, but also for curved work, as, for example, spirals and



Courtesy of The Cincinnati Milling Machine Co.
Fig. 14.—The saddle of a modern milling machine. Here all internal parts as well as the table bearings are oiled from two centralized stations at the rear.

worms, or the cutting of spur bevel and helical gears. In other words the milling machine can be regarded as the "utility man" in the shop due to the extensive number of functions which it is capable of performing. To carry out any one of these it is generally only necessary to use a specially designed cutter with teeth conforming to the nature of the cut to be made.

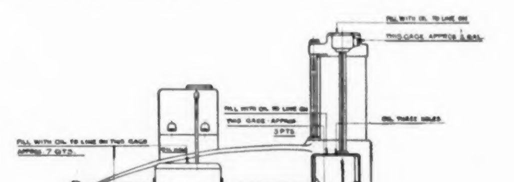
Lubrication

One of the most interesting features which has accompanied the development of the modern milling machine has been the trend towards automatic lubrication. A milling cutter performs its work at a single pass and actually removes the requisite metal at a relatively rapid rate. Therefore, it is absolutely necessary that the work table, spindle and all supports and operating mechanisms are so designed and constructed that there will be no tendency for the work to spring away from the cutter when it is subjected to the strains of cutting.

But it would not suffice to rely upon rigidity and strength alone to take up these cutting strains. Wear on all frictional elements would only be probably increased in proportion. Therefore, positive lubrication must be resorted to. That is, lubrication so carried out that a continuous feed of oil is directed to all these wearing parts under sufficient pressure to preserve a suitable fluid film between them and prevent metal-to-metal friction. The extent to which such a lubricating system would have to be planned would, of course, depend to a large degree upon the working pressures which might be developed.

There are some builders who regard flood lubrication as so essential that they have designed their machines with absolutely self contained oiling systems, the lubricant being pumped to the wearing parts by means of a suitable pump adjacent to or located in the oil reservoir itself. Thus, throughout operation a flood of oil is continually passing over all gears and bearings. In such a system the one grade of oil, i. e., a medium viscosity straight mineral machine oil would usually give satisfactory lubrication of all the wearing parts involved.

Splash and bath lubrication of gears and frequently many of the other bearings, is also used on certain types of milling machines. Such systems are particularly adaptable to column mechanisms, for with the gears of the drive shafts running submerged in oil, a sufficient amount of this latter is splashed to all parts of the column to effectively lubricate the bearings. Here, however, the lubricant does its work under relatively low pressure, volume being relied upon to maintain the requisite oil films. Therefore, whereas a machine oil of perhaps 200 to 400 seconds Saybolt at 100 Deg. Fahr., might suffice in a pressure oiling system, a heavier product even approximating a low viscosity mineral cylinder oil might be necessary for splash or bath lubrication.



Courtesy of The Carlton Machine Tool Co.
Fig. 15.—A radial drill designed for automatic lubrication throughout. Note the several points of lubrication and the instructions for same. Forced lubrication is employed in the head; and gears run in oil baths. All shafts are carried in Strom type ball bearings.

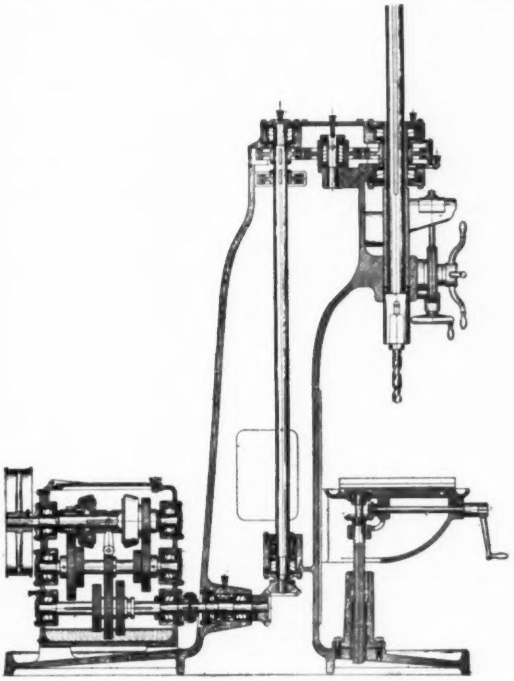
BORING MILLS AND DRILLING MACHINES

To this time we have dealt solely with machines which do their cutting over exterior surfaces in general. On many classes of work,

however, the boring out or drilling of depressions or holes is quite as important as planing, milling or turning down of their surfaces. For this work boring mills or drills are used.

Boring Mills

The larger machines are termed boring mills. Their essential function is to bore out machine



Courtesy of Hyatt Roller Bearing Co.

Fig. 16.—Line sketch of a drill showing the extent to which roller bearings can be applied to the important bearings.

parts, such as car wheels, engine connecting rods, etc., and differential housings or crankcases in the automobile industry. In fact one of the most frequent functions of a boring machine is to drill or bore out the aperture, which is to ultimately house a shaft and its accompanying bearing. Boring machines or mills are built either horizontally or vertically, according to the work which is to be handled. The horizontal mill is adaptable to work which cannot be readily revolved, the tool, therefore, being the rotating element. This machine is also suited to the boring of long or deep holes and the boring of more than one hole in the same piece especially where these holes are located in different planes.

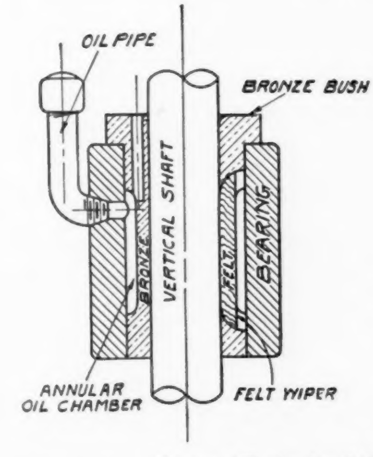
An additional feature of the horizontal boring mill is that it has a wide field of application, being capable of not only boring but also milling and drilling.

The vertical boring mill, on the other hand, is more especially adapted to work which can be revolved. In other words it is used for work which can be fastened to the table and rotated thereon. As a rule, therefore, machine parts of relatively smaller caliber, such as pulleys, gears, piston heads, machine discs and casings, etc. are finished on vertical boring mills. These machines are claimed to reduce the effects of centrifugal force due to the fact that the work can be more easily balanced.

Lubrication

Boring Mills involve much the same type of wearing parts as the lathe, or planer, etc. In other words there are the driving gears, the feed and traverse gears, the screw by which the table and saddle are adjusted, the V-tracks on which the saddle rests, and the miscellaneous bearings and guides involved in connection with the above, etc. In certain types of boring mills considerable thrust will be exerted upon the spindle or boring bar. This is especially prevalent on the horizontal machine, and for this reason many such mills are built with V-tracks on either side of the spindle. These V's take up the thrusts of operation effectively, provided they are properly lubricated.

Experience has proven that in general all the wearing parts of a boring mill will function most satisfactorily if provision is made for forced lubrication. Builders have realized the enormous pressures which must sometimes be carried by certain of the wearing parts of their machines. They have furthermore realized that where equipment of the size and com-

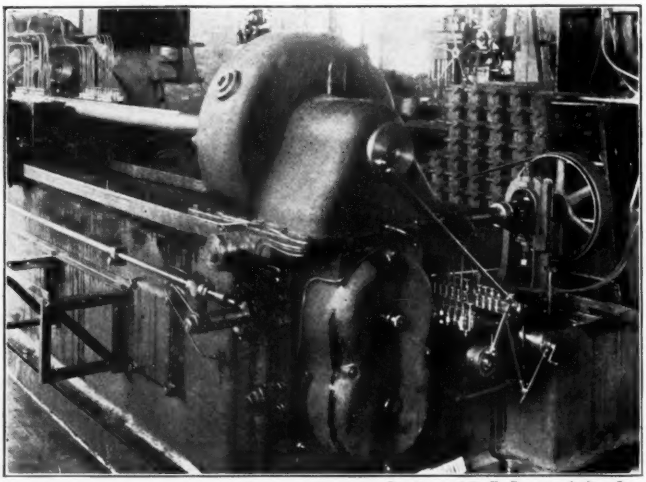


Courtesy of The American Tool Works Co.

Fig. 17.—The oiling diagram of a radial drill vertical bearing. Here the oil is led to the annular oil chamber from which it feeds to the bearing by means of a strip of felt.

plexity of the boring mill is involved, the most dependable results are attained if the operator is not expected to combine the duties of an oiler with his more specific duties of producing the maximum of correctly machined products.

For the general lubrication of boring mills a medium bodied straight mineral oil has been found to be most satisfactory. Essentially it must be of the same characteristics as the oil used elsewhere in the shop. For all round lubrication a viscosity of from 200 to 400 sec. Saybolt at 100 Deg. Fahr. will be usually found to be suitable. Such an oil will have sufficient body to not only serve the bearings, but also the slides and gears where it is delivered under sufficient pressure. In cases where gears are not enclosed in oil tight casings, or, on rack, worm or screw mechanisms a somewhat heavier product might be advisable. Frequently a viscosity of approximately 1000 seconds Saybolt at 210 Deg. Fahr. would be necessary for such service. For other gearing which operates enclosed and designed for splash lubrication a straight mineral oil of a viscosity akin to a light steam cylinder oil would probably serve the purpose best.



Courtesy of S. F. Bowser & Co., Inc.

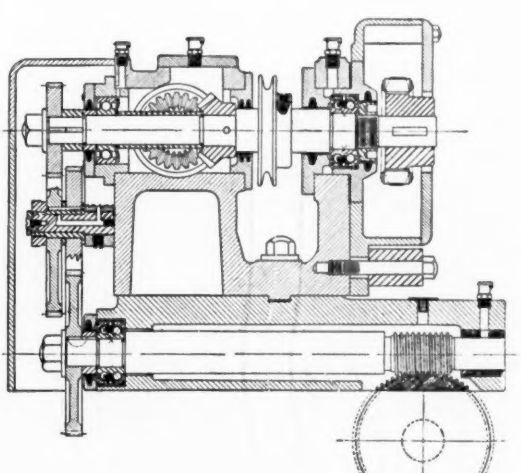
Fig. 18.—An Allis-Chalmers six bar boring mill equipped for force feed lubrication. Note the ratchet driven lubricator in the right foreground and the numerous oil leads to the various working parts.

Drilling Machines

Where boring operations involve the tapping of relatively small holes, reaming or counterboring, either singly or in multiple, drills of vertical, radial, horizontal or multiple-spindle type are usually employed. Drilling machines embody an extensive variety of types and arrangements, according to the class of work they are designed to perform. It is interesting to note that they can be used for facing, threading or outside turning in many cases, thus supplanting the lathe to a certain extent. They are, therefore, regarded as distinctly advantageous machines wherever they are capable of using several types of drills or cutting tools on a wide variety of work.

Drilling machines are usually subjected to high production requirements. They operate at relatively high speeds and in proportion to the size, their wearing parts are subjected to high pressures. Therefore the average vertical, radial or multiple spindle machine today may develop many vexing frictional and lubricating problems. In other words, as in all equipment subjected to high rotational speeds and bearing pressures, the maintenance of requisite lubricating films between bearings, guides and gear teeth becomes more difficult and imposes more restrictions upon the oil being used.

High speeds are advantageous in drilling on account of the fact that breakage of drills or cutting tools is reduced, temperatures of cutting are often lower provided adequate means is employed for directing the cutting lubricant and coolant to the face of the tool, production is increased and there is less chance for burrs being formed. In other words cutting will be smoother. The smaller the holes the more advantageous will high speeds usually become. In this connection it is interesting to note that on certain grades of softer steel, speeds in the neighborhood of 16,000 R.P.M. have been economically attained.

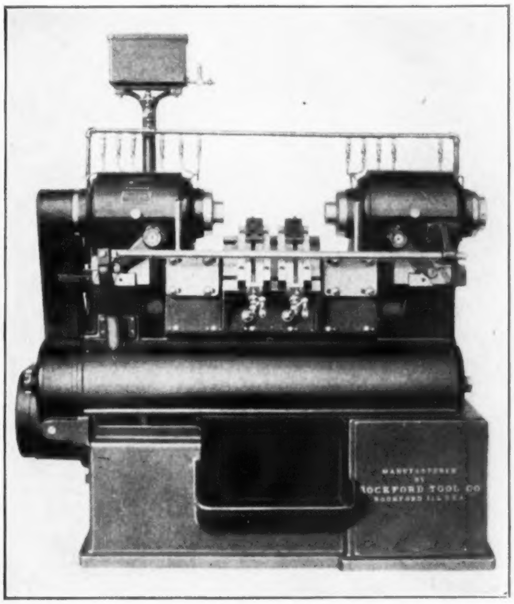


Courtesy of The New Departure Mfg. Co

Fig. 19.—A side view of a Waltham 4" gear cutter, equipped with ball bearings.

Lubrication

But only is this possible provided the working parts of the machine function absolutely in unison with respect to one another. To bring this about, lubrication is the logical recourse,



Courtesy of The Timken Roller Bearing Co.

Fig. 20.—A Rockford bolt threading machine equipped with roller bearings. Note the oil reservoir and adjacent distributing pipes above.

assuming that the machines are properly designed and constructed.

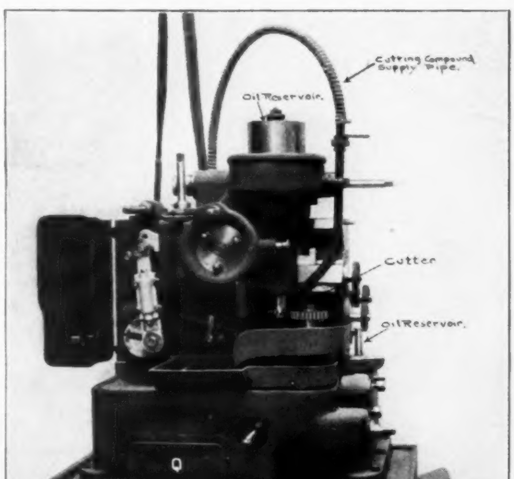
Centralized automatic lubrication has been developed to a marked extent in this connection, and is today claimed to solve the lubrication problems so inherent to vertical bearings and high speeds. However the lubricating system may be designed or centralized, or however it may be rendered automatic, it is serving its purpose, provided it insures a sufficient supply of oil to all wearing parts of the drill. Furthermore, it is making possible the use of but one grade of oil, thereby reducing expense and the possibility of difficulty due to application of the wrong product at any time.

In connection with gearing, however, as with boring mills and other tools, there are, of course, some cases where these mechanisms will be designed for individual or separate lubrication. Naturally bath or splash oiling is preferable, and in such instances the same products heretofore specified under boring mills would be suitable. Exposed gearing or other toothed mechanisms running perhaps in non-oil tight casings, on the other hand will require a heavier product which will maintain an effective lubricating film on the teeth notwithstanding any action of centrifugal force which may be prevalent.

OTHER MACHINE SHOP EQUIPMENT

It is unfortunate that space limitations preclude any extensive discussion of the various other equipment found in many plants. Just because such machines as the grinder, screw and thread cutter, hobbing machine, chucking machine, etc., are to an extent more limited in application than the more massive tools already discussed, is no reason for classifying them as auxiliaries, even though they may amount to this in many shops. Their functions are distinctive, and quite as important in finishing the work as the machines already discussed.

Essentially their principles of operation will be much the same, i. e., the working of the material into suitable shape and design for subsequent use as tools or machine parts. This is brought about by cutting as in the gear-shaper, or by grinding as in the grinder. This latter machine is also used for buffing and polishing purposes. In consequence this equipment will therefore function by virtue of suitably arranged gearing, bearings for the rotating



Courtesy of The Fellows Gear Shaper Co.

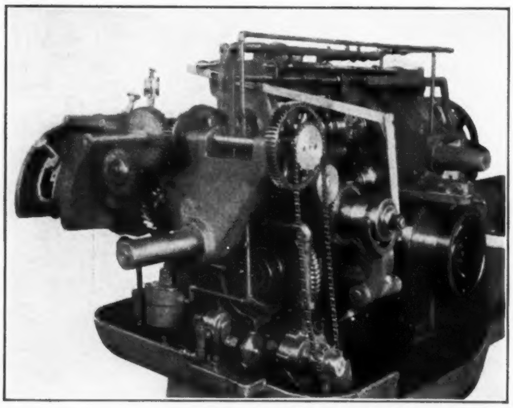
Fig. 21.—Front view of a gear shaper with guards removed, showing the principal oiling details.

members and guides or slides for such parts as are subject to reciprocating motion.

Lubrication

Hence their lubrication will differ but little from that already discussed. On such machin-

ery, however, the use of independent oil and grease cups will often be the most economical and satisfactory procedure. Automatic or flood lubrication, on the other hand is also provided for by certain builders. It is all a



Courtesy of The National Acme Company.

Fig. 22.—Working details of an automatic screw machine showing both cutting oil and lubricating pumps in the foreground adjacent to the pan. These are driven from the constant speed shaft by means of sprockets and chain.

matter of design, the speed at which the machine is to operate and the bearing or frictional pressures which may be developed.

As a result the same varieties of lubricants as recommended elsewhere in this article will in general be applicable to similar wearing parts on these so called auxiliaries. For instance on exposed gearing a relatively high viscosity straight mineral gear lubricant would probably be desirable whether we were dealing with a pipe threading and cutting machine or gear shaper, etc. Likewise, both splash or force feed lubricating systems would function very well if a 200 to 400 viscosity machine oil were used. For grease cups, in turn, dependent on whether they are of the compression or pin type, a grade of grease should be used which, under the operating temperatures involved, would liquify to just the right degree to afford proper lubrication.

This is an important feature in attaining effective grease lubrication, for it must be remembered that if a grease is too heavy or inert insufficient lubrication may result; whereas, if it is too fluid, in all probability it will run too rapidly through the lubricator and bearing resulting in direct waste.

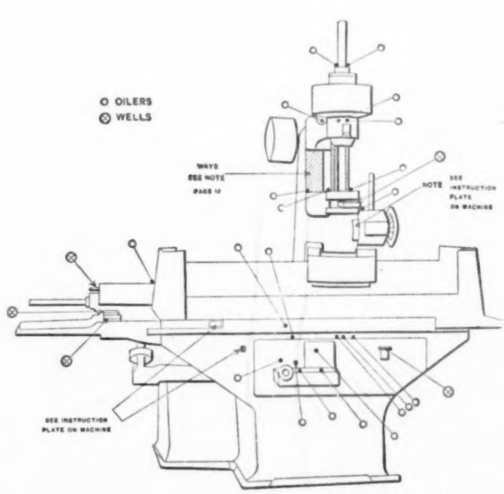
CONCLUSION

It will be noted that the matter of automatic lubrication has been stressed wherever possible and every opportunity taken to further an insight into the working details of the more accepted lubricating systems in use today in the machine tool industry.

Primarily this has been influenced by a natural preference on the part of the lubricating engineer for automatic lubrication due to the extent to which it promotes efficient operation, saving in lubricants, and increased production. It should not be assumed, however, that individual lubrication of many bearings, etc., is not perfectly feasible and oftentimes the most economical procedure. It is all a matter of machine construction, and operating requirements. The individual oiler, the pin type or compression grease cup, and the squirt can are, therefore, extensively used in every shop and tool room today.

In the application of individual lubrication, however, due consideration must always be made for the lubricating requirements of the parts involved, the labor conditions and the safety of the operators. On intricate massive machinery where lubricating requirements are frequently severe, splash, force feed or bath lubrication would in general be probably the most satisfactory. On the other hand, the numerous smaller external wearing parts so necessary to every type of machine tool can be more economically lubricated by hand via suitable oilers, or with grease cups. Especially is this true where no risk is entailed by the operator in performing his daily lubricating duties.

In connection with this matter of machine lubrication it is fitting to state in closing that



Courtesy of Pratt & Whitney Company.

Fig. 23.—Line sketch of a surface grinder showing the parts requiring oiling and the lubricating mediums installed.

cutting tool lubrication and cooling has not been dealt with, it being regarded as a subject worthy of an entirely independent discussion. In all probability this will be made in a later issue of LUBRICATION.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.
47 West Street, N. Y. C.